

the *flexor perforans* and runs to the third digit. These slips are in addition to the ordinary short flexors, and it is possible that they throw light upon the origin of the very peculiar modes of distribution of the hallucis tendon in some groups of birds, as it has been repeatedly shown that a tendon may be the homologue of a muscle.

*Entepicondylulo-ularis*.—This muscle, which according to Gadow is present only in Rasores and in the Tinamou, is absent in *Opisthocomus*. This is another of the innumerable points separating *Opisthocomus* from Fowls.

2. On the Occurrence of Schlegel's Gavial (*Tomistoma schlegelii*) in the Malay Peninsula, with Remarks on the Atlas and Axis of the Crocodilians. By G. A. BOULENGER, F.R.S.

[Received May 29, 1896.]

A Gharial-like Crocodile, *Tomistoma schlegelii*, described by Salomon Müller in 1838, was, until lately, believed to be peculiar to Borneo. In 1890, however, its occurrence in Sumatra was recorded by Max Weber (*Zool. Ergebn.* p. 176). The Malay Peninsula may now be added to its habitat.

A few months ago, the British Museum received, from Mr. L. Wray, Curator of the Perak Government Museum, a fine half-grown specimen, with the following remarks:—

“The specimen was caught at Pulau Tiga, in the Perak river, in June 1895, and I kept it in a pond until the end of December, when it was killed. For months it would eat nothing but a few small fish, but during the later portion of the time it would eat freely of any meat or fish given to it. It also became quite tame and would remain at the surface of the water with its head on the bank while people stood near it.

“So far as I have been able to ascertain, no Crocodile belonging to the Gavial group has ever been recorded from the Malayan Peninsula, so that the following particulars will be of interest.

“I first heard of the occurrence of a Gavial in the State of Perak in 1889, and in the same year Mr. Cecil Wray, the then Acting Superintendent of Lower Perak, obtained a skull from the Perak river, and sent it to the Perak Museum; the animal was 7 feet long. A second was caught in the Kinta river, near Batu Gajah, in 1893 or 1894. It was secured by Capt. H. C. Metcalfe, of the Perak Sikhs, and the skin is now in his possession. It measures 6 feet 8 inches, but the tail is very short, having probably been injured when young; the head measures 18 inches, the upper jaw 30 inches, and the lower jaw 23 inches. A third was taken from the Batang Padang river near Tapah, and was seen by Mr. Page, the Inspector of Police at Tapah. It was

stated to have been a small one, only measuring about 4 feet long, and, unfortunately, it was not preserved.

"Mr. J. P. Rodger informed me that, when he was British Resident in Pahang, he had seen the skull of one belonging to the late Mr. E. A. Wise, that had been caught in the upper part of the Pahang river. The fifth was trapped in the Perak river at Pulau Tiga, some 64 miles from the mouth. This animal measured 8 feet 9 inches, and is the largest yet seen.

"I was informed some years ago that one was taken to the Police station at Telok Anson for the reward, measuring 19 feet in length. The Police Inspector showed me where it was buried, but I failed to find it. Four skeletons were dug out, but they all proved to be common Salt-water Crocodiles (*Crocodilus porosus*). There is therefore considerable doubt about the accuracy of this information, and probably the animal was only a rather narrow-headed common Crocodile and not a Gavial at all.

"These are all the instances of its occurrence that I have been able to collect, and so far the evidence would go to show that it is confined to the Perak and Pahang rivers and some of their larger tributaries; though it is probable that it will hereafter also be found in the Kelantan and possibly in the Telubin river.

"It is called by the Malays 'Buaya Jinjulong,' or the Long-snouted Crocodile; but from its rarity there are only a very few who have ever either seen or heard of it. There are two other crocodiles frequenting the coasts and rivers of the Peninsula, viz. the Salt-water Crocodile (*Crocodilus porosus*, Schn.) and the Marsh Crocodile (*C. palustris*, Less.). These are called respectively 'Buaya' and 'Buaya Katak,' or the Frog Crocodile, by the Malays. 'Buaya Tembaga,' that is the Brass Crocodile, is a name often heard, but it only has reference to the colour, being indifferently applied to all yellowish-tinted ones without regard to their species.

"The Malayan Gavial would appear to be essentially a freshwater animal, and it is said by the natives to often frequent the swamps and marshy lands on the banks of the rivers. If this is really the case, it differs somewhat in its habits from the *Gavialis gangeticus*, which is much more aquatic than the Crocodile. In the ordinary way, so far as my observations have gone, only the upper part of the end of the nose and the two eyes are above the water. On the approach of anyone the eyes slowly and quite silently sink beneath the surface and nothing but a small portion of the nose remains: on a nearer approach this also quietly disappears. This doubtless accounts for the fact that the animal is so very rarely seen.

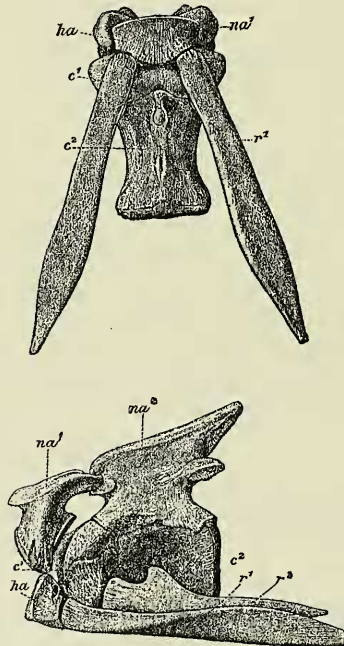
"The irides are yellowish brown and the pupils vertical. The upper surface is pale dull olive-green, finely and closely spotted with dark brown. The ground-colour becomes lighter on the sides and is nearly white beneath. The tail has six dark bands, formed by the spotting of the scales on the sides and lower surface with dark brown. In the living animal the upper jaw projects nearly an inch beyond the under jaw.

"It is possibly referable to *Tomistoma schlegeli*, the Bornean Gaval, but the very meagre description of that species in my possession is insufficient to identify it."

The specimen sent by Mr. Wray has been stuffed, and is now exhibited in the Reptile Gallery of the Natural History Museum. As the bones were sent with the skin, I am able to add some remarks on the osteological characters, of which we know nothing, except of the skull, which has been well described and figured.

There are 24 præ-sacral, 2 sacral, and 35 caudal vertebræ. The

Fig. 1.

Atlas and axis of *Tomistoma*, ventral and side views.

(The posterior condyle of the axis is omitted.)

c. Centrum.		na. Neural arch.
ha. Hypapophysis.		r. Rib.

hypapophyses on the cervical and anterior thoracic vertebræ are less developed than in the other recent Crocodylians, and are not directed forwards; they are not developed beyond the eleventh vertebra (twelfth or thirteenth in the others). The chevron-bones are all open dorsally. The first pair of ribs are inserted on the sides of the proatlanto-atlantic hypapophysis, or lower part of the atlas-ring, and separated from each other at the base by a wide interspace. The second rib differs from that of all Crocodylians I have hitherto examined (including the Gavial, of which I have examined the bone on a young specimen in spirit, and also the atlas and axis preserved in the Museum of the Royal College of Surgeons,—the Gavial-skeleton still being a desideratum in the British Museum Collection), *Osteolemus* excepted; it is attached to the centrum of the atlas (odontoid bone), near its suture with the axis, by the capitulum only, the tuberculum being merely indicated by a small upward process at a distance from the base of the bone, and without any connection with the vertebræ.

It is well known that in *Ichthyosaurus* the atlas bears a forked rib, same as the axis and the other vertebræ behind it. It seems that one Crocodylian at least presents an approximating feature. The late Mr. Hulke has first pointed out in *Metriorhynchus* (P. Z. S. 1888, p. 419) the presence on the "lateral pieces" (neurapophyses) of the atlas of a tubercle situated in the level of the diapophysis on the epistrophæus, and he concludes that this tubercle should rank as an upper atlantal transverse process or diapophysis. I have been able to verify the correctness of this statement on several well-preserved atlases of *Metriorhynchus*, still undescribed, from the Leeds Collection, which my colleague Mr. Andrews has kindly shown me in the Geological Department of the British Museum; and I quite agree with Hulke that "the position of this little process in serial line with the upper transverse processes of the other cervical vertebræ speaks distinctly in favour of its diapophysial character." We are, in consequence, justified in assuming that, although, as we know from one specimen, the first rib is not forked, it must have been connected with the diapophysis by ligament, its head being attached to the side of the hypapophysis ("basilar piece") of the atlas, or rather between the latter and the centrum (odontoid bone); and such a condition may be regarded as the most primitive known among Crocodylians, and as one from which, as Hulke has shown, the abnormal position of the first rib of recent forms may be derived and explained.

The second rib in *Metriorhynchus* was attached by its capitulum to the anterior border of the lower surface of the centrum of the axis, or between the latter and the centrum of the atlas, and by its tuberculum to a process (diapophysis) of the neurapophysis of the axis.

As regards recent Crocodylians, the information to be derived from books appears contradictory, principally from the fact that the various authors have dealt with different genera, and have in some cases generalized their observations to the whole group.

Cuvier (Ossem. Foss.) describes and figures the second rib in *Crocodylus porosus* as single-headed and attached to the odontoid bone. Owen (Osteol. Cat. Mus. Coll. Surg.) ascribes to the same rib, in *Gavialis gangeticus*, a forked head attached to two transverse processes of the odontoid bone. According to Stannius (Zoot. Amph. p. 26), the rib is forked and the two branches are attached on the limit between the odontoid bone and the centrum of the axis. Brihl (Skel. Crocod.) figures, in *Caiman palpebrosus*, the rib as forked, with capitulum and tuberculum on the odontoid bone, near its suture with the axis. In Huxley's 'Anatomy of Vertebrated Animals' it is described in Crocodilians generally as attached to the os odontoideum and to the second centrum by distinct capitular and tubercular processes. Baur (Amer. Nat. 1886, p. 228) was the first in attempting to show what, if any, differences exist between the genera with regard to the shape of the second rib and its attachment to the vertebrae. I am not able to confirm his statements regarding *Gavialis* and *Alligator*. In the case of the latter, the more forward position assigned by him to the costal capitulum may be due to individual variation; but I cannot help thinking the author is mistaken in attributing a rudimentary diapophysis to the neural arch of *Gavialis*. In the specimens I have examined two very distinct processes are present on the axis-centrum, and I have satisfied myself on a specimen in spirit that the ligamentous capitulum is attached to the upper of these processes, which is widely separated from the supposed diapophysis figured by Dr. Baur.

I have examined the atlas and axis in *Gavialis gangeticus*, *Tomistoma schlegeli*, *Crocodyli niloticus*, *americanus*, and *porosus*, *Osteolemus tetraspis*, *Alligator mississippiensis*, *Caiman sclerops* and *C. latirostris*, and find important differences, which are deserving of notice.

In *Alligator*, the first rib is attached to the lower surface of the hypapophysis and in contact with, or narrowly separated from, its fellow at the base; the second rib, in the adult, is deeply forked and attached by its capitulum to the centrum of the atlas, by its tuberculum to the anterior part of the centrum of the axis, which, however, does not develop any tubercle or transverse process. In a new-horn specimen I find both capitulum and tuberculum inserted on the axis, showing the rib to shift forward with age, a further confirmation of the view that this rib, usually attached to the first vertebra, really pertains to the second.

In *Caiman*, the first rib is as in the preceding, but the second, deeply forked, is entirely on the centrum of the atlas, without the latter bearing processes for its attachment.

In *Crocodylus*, the first rib is more on the side of the hypapophysis and widely separated from its fellow; the second is but feebly notched in its proximal portion, and the somewhat ill-defined capitulum and tuberculum join two strong knob-like processes on the centrum of the atlas.

In *Gavialis*, the first rib conforms to the preceding type, but

the second is deeply bifurcate, the tuberculum ligamentous, and attached to two processes on the centrum of the atlas.

*Tomistoma* has been noticed above. *Osteolemus*, curiously, agrees with it.

We thus see that *Metriorhynchus* represents the most generalized condition, and that the recent Crocodylians, each departing in its way from the primitive type, cannot be arranged in a continuous series in this any more than in several other parts of their structure. Whilst more generalized in respect to the second rib<sup>1</sup> than the true Crocodiles, the Alligator is more specialized in the more aberrant position of the first rib; the Gavial agrees with the Crocodile in the position of the first rib, and with the Alligator and Caiman in the strong bifurcation of the second; and *Tomistoma* and *Osteolemus* present the highest specialization in the condition of the second rib with rudimentary tuberculum.

P.S. (June 18, 1896).—Two days after the reading of my paper, I received Dr. Gadow's memoir on the Vertebral Column of Amphibia and Amniota (Phil. Trans. clxxxvii. B. pp. 1-57). In this he gives an account and a diagrammatic figure of the atlas and axis of *Metriorhynchus*, which differ entirely from what I have observed. I at once re-examined the specimens, and particularly that described by Hulke and figured by Dr. Gadow, and find

Fig. 2.



Atlas and axis of *Metriorhynchus*.

c. Centrum.	na. Neural arch.
cp. Capitular facet.	t. Tubercular facet (diapophysis).
ha. Hypapophysis.	

the latter's statement to be erroneous. What is figured as the first centrum is a portion of the first neural arch, the posterior portion of which has passed, on the figure, into the second vertebra; the tubercle (*t*<sup>1</sup>), to which allusion is made, is on the neural arch. I append (fig. 2) a corrected sketch of the specimen figured by Dr. Gadow.

<sup>1</sup> Another character in which *Alligator* is more generalized than *Caiman* and *Crocodylus* exists in the prontoslas, the arches of which are distinct or show at least a trace of separation, which is not to be found in the other genera, even in quite young specimens.